SPECIFICATION

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RESONANT FREQUENCY ADJUSTMENT USING TUNABLE DAMPING RODS

Cross Reference to Related Applications

This application claims priority from application number 60/207.642, filed May 26, 2001.

Background of Invention

[0001] A mechanical element may have at least one intrinsic resonant frequency. That resonant frequency may be in the audio range. Audio stimuli may therefore excite the mechanical element, and cause the mechanical element to react in some way. The reaction of the mechanical element may be undesirable. Moreover, since the effect of resonance may be highly amplified and exaggerated, this effect may become undesirable and especially problematic at resonance.

[0002] A remedy has been suggested to apply some sort of damping to such elements. Damping, however, works best at higher frequencies. In contrast, many of the resonances occur at lower frequencies. Hence, the damping has not been highly effective.

Summary of Invention

[0003] The present application teaches a special tunable damping system. The damping system may include a tunable damping rod. Tuning of the damping may become possible to prevent or minimize undesirable resonance.

Brief Description of Drawings

[0004] These and other aspects will now be described in detail with reference to the accompanying drawings, wherein:Figure 1 shows an embodiment with a tunable damping rod applied to an enclosure; andFigure 2 shows the damping rod used with an engine.

Detailed Description

[0005] A tunable damping rod is shown in Figure 1 within a speaker enclosure. This tunable damping rod may increase the resonant frequency of a mechanical element. The tunable damping rod operates by applying tension to the part. The amount of tension may be variable using a screw operation. Moreover, since this system increases the resonant frequency, the efficiency of tuning may be improved.

[0006] In a loudspeaker enclosure, a moving speaker driver shown generically as 199 may excite undesirable resonance in the enclosure. Taking an example of a woofer, the moving woofer may excite undesirable resonance in the enclosure. This resonance may radiate from the cabinet walls as additional sound waves. The area of the enclosure walls are typically much larger than the area of the woofer. Hence, it even small resonance amounts may radiate audible sound levels. This extra sound may not be true to the music, and may be undesirable.

[0007] A tunable damping rod is used to eliminate enclosure resonance. In the embodiment shown in Figure 2 the enclosure 200 has first and second parallel sides 202, 204. Holes 206, 208 are respectively formed in the sides 202, 204. A threaded rod 210 is placed through the holes to thereby extend from one end of the enclosure to the other. Washers 211, 212 are inserted on respective ends of the rod 210. Bolts 213,214 are then coupled over the washer, and are then tightened. The tightening of the bolts 213, 214 causes the washers 211,212 to be tightened against the enclosure walls 202, 204. This tightening operation builds up tension in the enclosure walls, causing them to bow slightly towards one another.

[0008]

By tensioning the enclosure walls, the fundamental resonance of the enclosure

is raised in frequency. This is analogous to the way in which a guitar string has its resonant frequency increased when tightened. Higher frequency resonances tend to decay faster than lower frequency resonances, and hence may be more difficult to excite. Accordingly, by increasing the resonant frequency of the cabinet, less excitation may be caused based on the existing energy.

[0009] In the example of a woofer enclosure, the enclosure may be tensioned in such a way as to increase its resonant frequency outside the bandwidth of the woofer. If this happens, no energy may excite the resonance of the cabinet, thus rendering the cabinet substantially resonance free.

[0010] In some other cases, it may be not be practical or possible to place enough tension on the rod. For example, the amount of necessary tension might be enough to break or otherwise stress the enclosure. In a second embodiment, the frequency of the enclosure resonance is tuned using the damping rod to a frequency that is absorbed by the material of the enclosure. For example, the enclosure may be tuned to a frequency where the enclosure material is highly damping.

[0011] Alternatively, a piece of constrained layer damping material, or C.L.D material, may be placed underneath the washer 211, 212 or may act as the washer itself. The tightening may be carried out to place a sufficient amount of tension on the enclosure to match the frequency where the CLD may best absorb. Another embodiment may place damping material in the enclosure in a way to damp frequencies, and again may be tuned to match the best damping of the damping material.

[0012] The above has described using this technology for speaker enclosures. However, other applications of these damping devices may be used. They may be used in industrial machinery, in automobiles to adapt to engine vibrations, buildings, where support rods may operate to damp the effect of earthquakes, home appliances, and other audio and visual components such as televisions, amplifiers, receivers, and others. In each of these applications, the tensioning element may be attached between two facing surfaces, and tightened to increase

the tension between the surfaces. Figure 2 shows the damping rod used in an automobile engine. The rod may be placed at any location on the engine.

[0013] All such modifications are intended to be encompassed within the following claims, in which: